Claims

1. (previously presented) In a computer system, a method of decoding images in a sequence of video images, the method comprising:

receiving and decoding a code in a bit stream to determine a fraction for a current image in the sequence, wherein the fraction represents an estimated temporal distance position for the current image relative to an interval between a first reference image for the current image and a second reference image for the current image, and wherein the determination of the fraction is independent of actual temporal distance positions of the respective reference images; and

for motion compensation for a direct mode macroblock in the current image, processing the fraction along with a motion vector for a co-located macroblock in the first reference image, wherein the motion vector represents motion in the first reference image relative to the second reference image for the current image, and wherein the processing the fraction along with the motion vector results in a representation of motion for the direct mode macroblock in the current image relative to the first reference image and relative to the second reference image.

2. (previously presented) The method of claim 1 wherein the fraction is represented by the code, and wherein the code comprises a variable length code in the bit stream.

3. (previously presented) The method of claim 1 wherein the fraction is selected from a set of discrete values, wherein each of the values is greater than zero and less than one so as to indicate the estimated temporal distance position within the interval.

4. (original) The method of claim 1 wherein the fraction is selected from the group consisting of: 1/2, 1/3, 2/3, 1/4, 3/4, 1/5, 2/5, 3/5, 4/5, 1/6, 5/6, 1/7, 2/7, and 3/7.

5. (previously presented) The method of claim 1 wherein the estimated temporal distance position for the current image relative to the interval between the first reference image for the current image and the second reference image for the current image is not the true temporal distance position of the current image.

6. (original) The method of claim 1 wherein the fraction is based on motion information for the sequence of video images.

7. (original) The method of claim 1 wherein the fraction is based on a proximity of the current image to an end of the sequence of video images.

8.-9. (canceled)

10. (previously presented) The method of claim 1 further comprising repeating the acts of claim 1 for each of plural bi-directionally predicted images in the sequence of video images.

11.-17. (canceled)

18. (previously presented) In a computer system, a method of encoding images in a sequence of video images, the method comprising:

determining a fraction for a current image in the sequence, wherein the current image has a previous reference image and a future reference image, and wherein the fraction represents a temporal position for the current image relative to the respective reference images;

selecting direct mode prediction for a current direct mode macroblock in the current image;

finding a motion vector for a co-located macroblock in the future reference image;

scaling the motion vector for the co-located macroblock using the fraction;

using results of the scaling in motion compensation for the current direct mode macroblock in the current image; and

outputting a code in a bit stream, wherein the code represents the fraction, and wherein the outputting the code facilitates determination of the fraction independent of actual temporal positions of the respective reference images during decoding.

19. (original) The method of claim 18 wherein the fraction facilitates representation of variable velocity motion in the direct mode prediction.

20. (previously presented) The method of claim 18 wherein the scaling the motion vector for the co-located macroblock comprises scaling a vertical component and a horizontal component of the motion vector for the co-located macroblock.

21. (previously presented) The method of claim 18 wherein the scaling the motion vector for the co-located macroblock comprises:

scaling the motion vector for the co-located macroblock by a factor of the fraction, to obtain an implied forward motion vector for the current direct mode macroblock; and

scaling the motion vector for the co-located macroblock by a factor of the fraction minus one, to obtain an implied backward motion vector for the current direct mode macroblock, wherein for the direct mode macroblock the motion compensation uses the implied forward motion vector and the implied backward motion vector.

22.-73. (canceled)

74. (previously presented) The method of claim 2 wherein the determination of the fraction comprises looking up the variable length code in a variable length code table to obtain a value for the fraction.

75. (previously presented) The method of claim 74 wherein at least one entry in the variable length code table represents a frame type, and wherein the frame type is B/I-frame.

76. (previously presented) The method of claim 1 wherein the processing the fraction along with the motion vector comprises scaling the motion vector for the co-located macroblock using the fraction.

77. (previously presented) The method of claim 76 wherein the scaling the motion vector for the co-located macroblock comprises scaling a vertical component and a horizontal component of the motion vector for the co-located macroblock.

78. (previously presented) The method of claim 76 wherein the scaling the motion vector for the co-located macroblock comprises:

scaling the motion vector for the co-located macroblock by a factor of the fraction, to obtain an implied forward motion vector for the direct mode macroblock; and

scaling the motion vector for the co-located macroblock by a factor of the fraction minus one, to obtain an implied backward motion vector for the direct mode macroblock.

79. (previously presented) The method of claim 78 wherein the motion compensation comprises:

addressing a macroblock in the future reference image using the implied forward motion vector;

addressing a macroblock in the previous reference image using the implied backward motion vector; and

predicting the current macroblock using an average of the macroblock in the future reference image and the macroblock in the previous reference image.

80. (currently amended) A system comprising:

one or more processors;

memory;

at least one input device, output device or communication connection; and

one ~~One~~ or more ~~computer-readable~~ storage media having stored thereon computer-executable instructions for causing one or more computers to perform a method of decoding images in a sequence of video images, the method comprising:

______receiving and decoding a code in a bit stream to determine a fraction for a current image in the sequence, wherein the fraction represents an estimated temporal distance position for the current image relative to an interval between a first reference image for the current image and a second reference image for the current image, and wherein the determination of the fraction is independent of actual temporal distance positions of the respective reference images; and

______for motion compensation for a direct mode macroblock in the current image, processing the fraction along with a motion vector for a co-located macroblock in the first

reference image, wherein the motion vector represents motion in the first reference image relative to the second reference image for the current image, and wherein the processing the fraction along with the motion vector results in a representation of motion for the direct mode macroblock in the current image relative to the first reference image and relative to the second reference image.

81. (currently amended) The ~~computer-readable storage media~~ system of claim 80 wherein the fraction is represented by the code, and wherein the code comprises a variable length code in the bit stream.

82. (currently amended) The ~~computer-readable storage media~~ system of claim 80 wherein the fraction is selected from a set of discrete values, wherein each of the values is greater than zero and less than one so as to indicate the estimated temporal distance position within the interval.

83. (currently amended) The ~~computer-readable storage media~~ system of claim 80 wherein the fraction is selected from the group consisting of: 1/2, 1/3, 2/3, 1/4, 3/4, 1/5, 2/5, 3/5, 4/5, 1/6, 5/6, 1/7, 2/7, and 3/7.

84. (currently amended) The ~~computer-readable storage media~~ system of claim 80 wherein the estimated temporal distance position for the current image relative to the interval between the first reference image for the current image and the second reference image for the current image is not the true temporal distance position of the current image.

85. (currently amended) The ~~computer-readable storage media~~ system of claim 80 wherein the fraction is based on motion information for the sequence of video images.

86. (currently amended) The ~~computer-readable storage media~~ system of claim 80 wherein the fraction is based on a proximity of the current image to an end of the sequence of video images.

87. (currently amended) The ~~computer-readable storage media~~ system of claim 80 wherein the determination of the fraction comprises looking up the code in a code table to obtain a value for the fraction.

88. (currently amended) The ~~computer-readable storage media~~ system of claim 87 wherein at least one entry in the code table represents a frame type, and wherein the frame type is B/I-frame.

89. (previously presented) A method of encoding images in a sequence of video images, the method comprising:

determining a fraction for a current image in the sequence, wherein the fraction represents an estimated temporal distance position for the current image relative to an interval between a first reference image for the current image and a second reference image for the current image, and wherein the determination of the fraction is independent of actual temporal distance positions of the respective reference images;

for motion compensation for a direct mode macroblock in the current image, processing the fraction along with a motion vector for a co-located macroblock in the first reference image, wherein the motion vector represents motion in the first reference image relative to the second reference image for the current image, and wherein the processing the fraction along with the motion vector results in a representation of motion for the direct mode macroblock in the current image relative to the first reference image and relative to the second reference image; and

outputting a code in a bit stream, wherein the code represents the fraction.

90. (previously presented) The method of claim 89 wherein the code comprises a variable length code in the bit stream.

91. (previously presented) The method of claim 89 wherein the fraction is selected from a set of discrete values, wherein each of the values is greater than zero and less than one so as to indicate the estimated temporal distance position within the interval.

92. (previously presented) The method of claim 89 wherein the fraction is selected from the group consisting of: 1/2, 1/3, 2/3, 1/4, 3/4, 1/5, 2/5, 3/5, 4/5, 1/6, 5/6, 1/7, 2/7, and 3/7.

93. (previously presented) The method of claim 89 wherein the estimated temporal distance position for the current image relative to the interval between the first reference image for the current image and the second reference image for the current image is not the true temporal distance position of the current image.

94. (previously presented) The method of claim 89 wherein the fraction is based on motion information for the sequence of video images.

95. (previously presented) The method of claim 89 wherein the fraction is based on a proximity of the current image to an end of the sequence of video images.

96. (previously presented) The method of claim 89 wherein the determination of the fraction comprises looking up the code in a code table to obtain a value for the fraction.

97. (previously presented) The method of claim 96 wherein at least one entry in the code table represents a frame type, and wherein the frame type is B/I-frame.

98. (previously presented) The method of claim 89 wherein the determining the fraction comprises:

evaluating each of plural fractions to determine bit costs for encoding the current image using the respective fractions; and

selecting the fraction based on the evaluating.

99. (currently amended) <u>A system comprising:</u>

<u>one or more processors;</u>

<u>memory;</u>

<u>at least one input device, output device or communication connection; and</u>

one ~~One~~ or more ~~computer-readable~~ storage media having stored thereon computer-executable instructions for causing one or more computers to perform a method of encoding images in a sequence of video images, the method comprising:

______determining a fraction for a current image in the sequence, wherein the fraction represents an estimated temporal distance position for the current image relative to an interval between a first reference image for the current image and a second reference image for the current image, and wherein the determination of the fraction is independent of actual temporal distance positions of the respective reference images;

______for motion compensation for a direct mode macroblock in the current image, processing the fraction along with a motion vector for a co-located macroblock in the first reference image, wherein the motion vector represents motion in the first reference image relative to the second reference image for the current image, and wherein the processing the fraction along with the motion vector results in a representation of motion for the direct mode macroblock in the current image relative to the first reference image and relative to the second reference image; and

______outputting a code in a bit stream, wherein the code represents the fraction.

100. (currently amended) The ~~computer-readable storage media~~ system of claim 99 wherein the code comprises a variable length code in the bit stream.

101. (currently amended) The ~~computer-readable storage media~~ system of claim 99 wherein the fraction is selected from a set of discrete values, wherein each of the values is greater than zero and less than one so as to indicate the estimated temporal distance position within the interval.

102. (currently amended) The ~~computer-readable storage media~~ system of claim 99 wherein the fraction is selected from the group consisting of: 1/2, 1/3, 2/3, 1/4, 3/4, 1/5, 2/5, 3/5, 4/5, 1/6, 5/6, 1/7, 2/7, and 3/7.

103. (currently amended) The ~~computer-readable storage media~~ system of claim 99 wherein the estimated temporal distance position for the current image relative to the interval

between the first reference image for the current image and the second reference image for the current image is not the true temporal distance position of the current image.

104. (currently amended) The ~~computer-readable storage media~~ system of claim 99 wherein the fraction is based on motion information for the sequence of video images.

105. (currently amended) The ~~computer-readable storage media~~ system of claim 99 wherein the fraction is based on a proximity of the current image to an end of the sequence of video images.

106. (currently amended) The ~~computer-readable storage media~~ system of claim 99 wherein the determination of the fraction comprises looking up the code in a code table to obtain a value for the fraction.

107. (currently amended) The ~~computer-readable storage media~~ system of claim 106 wherein at least one entry in the code table represents a frame type, and wherein the frame type is B/I-frame.

108. (currently amended) The ~~computer-readable storage media~~ system of claim 99 wherein the determining the fraction comprises:

evaluating each of plural fractions to determine bit costs for encoding the current image using the respective fractions; and

selecting the fraction based on the evaluating.

109. (currently amended) A system comprising:

one or more processors;

memory;

at least one input device, output device or communication connection; and

one ~~One~~ or more ~~computer-readable~~ storage media having stored thereon computer-executable instructions for causing one or more computers to perform a method of encoding images in a sequence of video images, the method comprising:

______determining a fraction for a current image in the sequence, wherein the current image has a previous reference image and a future reference image, and-wherein the fraction represents a temporal position for the current image relative to the respective reference images;

______selecting direct mode prediction for a current direct mode macroblock in the current image;

______finding a motion vector for a co-located macroblock in the future reference image;

______scaling the motion vector for the co-located macroblock using the fraction;

______using results of the scaling in motion compensation for the current direct mode macroblock in the current image; and

______outputting a code in a bit stream, wherein the code represents the fraction, and wherein the outputting the code facilitates determination of the fraction independent of actual temporal positions of the respective reference images during decoding.

110. (currently amended) The ~~computer-readable storage media~~ system of claim 109 wherein the fraction facilitates representation of variable velocity motion in the direct mode prediction.

111. (currently amended) The ~~computer-readable storage media~~ system of claim 109 wherein the scaling the motion vector for the co-located macroblock comprises scaling a vertical component and a horizontal component of the motion vector for the co-located macroblock.

112. (currently amended) The ~~computer-readable storage media~~ system of claim 109 wherein the scaling the motion vector for the co-located macroblock comprises:

scaling the motion vector for the co-located macroblock by a factor of the fraction, to obtain an implied forward motion vector for the current direct mode macroblock; and

scaling the motion vector for the co-located macroblock by a factor of the fraction minus one, to obtain an implied backward motion vector for the current direct mode macroblock, wherein for the current direct mode macroblock the motion compensation uses the implied forward motion vector and the implied backward motion vector.